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ABSTRACT

This paper summarizes work from a dissertation, the main contribution of which was to develop and estimate a new empirical framework for analyzing the equilibrium outcomes of families' choices for choosing a particular residence. The principal component of the framework is a random-coefficients discrete-choice model of the residential location decision. This specification provides a form for utility, considering a household's preferences for a wide range of community features, including many that depend directly on how households sort across communities. The resulting estimates provide a complete picture of a household's preferences for the location, schools, crime, environmental amenities, sociodemographic composition, housing characteristics, and price, as well as how these preferences vary with its own characteristics, including its place of work, race, education, and income. The objectives of the dissertation were to provide insight into the underlying factors that drive matching of households with their schools, thereby expanding understanding of the issue, and to expand the conceptual and empirical framework for thinking about many of the economic and social issues related to the interactions of the local public economy, education market, and urban land and labor markets. (Author/WFA)

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Patrick J. Bayer

2001

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HOUSEHOLD MOBILITY, SCHOOL CHOICES, AND SCHOOL OUTCOMES

Patrick Bayer, Yale University*

THE COLLECTIVE RESIDENTIAL LOCATION DECISIONS made by the households of a metro politan area have an enormous impact on the quality of life that each of them enjoys. As Tiebout (1956) first pointed out, the sorting of households into distinct communities is the primary way that the economy allocates local public goods and services to households with different incomes and tastes for these goods. These collective location decisions also determine the socio-demographic composition of each neighborhood, which may have large welfare consequences if peer or neighborhood effects are important in schooling, crime, and labor market outcomes.

This paper summarizes work from my dissertation (Bayer, 1999), the main contribution of which is to develop and estimate a new empirical framework for analyzing the equilibrium outcomes of these collective residential location decisions. The principal component of this framework is a random-coefficients discrete-choice model of the residential location decision. This specification provides an extremely rich and flexible form for utility, considering a household's preferences for a wide range of community features, including many that depend directly on how households sort across these communities. The parameters of the utility function are recovered by appealing to the revealed preference principle (i.e., each household is assumed to have made its optimal location decision given the set of alternatives and the location decisions of other households). The resulting estimates provide a complete picture of a household's preferences for the attributes of its community (location, schools, crime, environmental amenities, socio-demographic composition, housing characteristics, and price) as well as how these preferences vary with its own characteristics, including its place(s) of work, race, education, and income.

Importantly, the parameters of the household utility function are estimated in a manner consistent with the fact that community socio-demographic compositions and housing prices are determined as part of the community sorting equilibrium. In addition to specifying the residential location decision, the empirical framework explicitly integrates a number of additional features that impact the housing market equilibrium including:

- The determination of the equilibrium vector of housing prices through the decentralized matching of buyers and sellers in the housing market;
- The endogenous sorting of households into communities based in part on direct preferences for the socio-demographic characteristics of their neighbors;
- An education production function that describes the production of achievement and depends in part on the socio-demographic composition of peers in the school; and
- The ability of households to opt out of the public school sector by choosing to send their children to private school.

I also introduce a new methodology for identifying social interactions in this framework–basing this identification strategy on the underlying geographic distribution of communities and their physical features within the major metropolitan areas of California. While this new framework is useful for addressing a wide range of questions in local public finance and urban economics, I focus the chapters of the dissertation on three issues related to the education market, which I have subsequently divided into three papers.

Tiebout Sorting and Discrete Choices. The first paper (Bayer, 2001c) uses the estimates of the preference parameters to explore the factors that drive the matching of households with the quality of schools their children attend. A household's residential location decision simultaneously sets its consumption of school quality as well as a full bundle of other local goods and its geographic location relative to its place(s) of work and the rest

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of the metropolitan area. In this way, a household's school quality decision is really a bundled consumption decision. Consequently, the quality of school that a family's children attend may be shaped by its preferences not only for school quality but also for other local goods, geographic preferences, and, importantly, the nature and location of the discrete bundles of local goods available in the market.

The extent to which a household's consumption of an element of this bundle of local goods deviates from its preferences is related directly to the thinness of the market for its preferred bundle. If, for example, a household prefers to purchase a small house in a community with high-quality public schools, its consumption of school quality may be lower than expected if small houses are not typically available in high-quality school districts.[1] The primary goal of this paper is to explore the extent to which the thinness of the housing market in certain dimensions amplifies differences in the consumption of school quality by families with different racial, education, and income characteristics.

Estimating the Role of Family Characteristics in Determining Achievement. The second paper, (Bayer, 2001b), uses the parameters of the residential location decision to estimate the role of family characteristics in the education production function in a manner consistent with the nonrandom sorting of households across districts. The standard approach to estimating the role of family characteristics in the education production function has been to regress an output measure, such as a test score, on a vector of family characteristics and a vector of school characteristics. Because this approach fails to account for the fact that households sort across communities and between the public and private sectors of the education market according to the same characteristics that directly affect the production of education, these estimates are subject to selection bias.[2] This bias results because the average family characteristics of a school district's students are correlated with the part of school quality that is observable by the households making their residential location and schooling decisions, but not observed by the econometrician. So, for example, in addition to its direct role in the determination of achievement, a large estimate on family income in the education production function may also capture the fact that high-income households can afford to live in high-quality school districts.

The size of the bias is likely to be particularly large in this context because researchers have had difficulty quantifying the aspects of a school that influence achievement. Consequently, most of the features of a school that attribute to achievement are likely to be unobservable, leading (if households get a better signal of quality than the econometrician) to a high degree of correlation between family characteristics and the unobservable component of the education production function. By explicitly controlling for the nonrandom sorting of households across districts, this paper provides better estimates of the role of family characteristics in the education production function.

Estimating the Determinants of the Public-Private School Choice. The third paper (Bayer, 2001a) explores the determinants of a household's choice between public and private school using the empirical framework described above, which considers simultaneously the household's residential location decision and school choice. A simultaneous approach to estimating these two important choices has not been undertaken in the literature to date. Instead, researchers typically have either adopted an empirical framework that takes the household's choice of community as given when estimating preferences for private and public school characteristics or aggregated the schooling data to very large geographic areas.

Taking the location as given when estimating the public-private school choice ignores the linkages between the education and housing markets that almost certainly ensure that each household makes both decisions at the same time. These linkages between the education and housing markets result from the capitalization of a community's public school quality and property tax rate into its property values and rents. Consequently, the attractiveness of a community with high-quality public schools is clearly greater for a household electing to send its children to public school rather than private school, ceteris paribus. By ignoring the household's location decision, previous estimates of the determinants of the private-public school choice are subject to a form of selection bias that results because the quality of a community's public school system affects not only which households choose public versus private education but also which households choose to live in the community in the first place.

The next section of this paper briefly summarizes the key elements of the empirical framework,

Table 2
Estimating the Education Production Function

Observation:	California elementary school district		
Dependent Variable:	Average sixth grade test score		
Mean:	273.44		
Standard Deviation:	28.25		
Number of Observations:	620		
		OLS	With Selection Correction
Family Characteristics (Z)			
% Black		-52.406	-40.210
		(8.248)	(11.598)
% Hispanic		-20.692	-14.443
		(3.497)	(7.004)
% HS degree or less		-45.822	-27.340
		(4.276)	(9.878)
% Income < $40,000		-29.174	-19.180
		(3.613)	(6.541)
School Characteristics (S)			
average class size		-0.109	0.085
		(0.197)	(0.161)
average school size (in hundreds)		-1.482	-1.236
		(0.373)	(0.334)
% employees—administrators		-52.926	-54.198
		(22.795)	(23.458)
% employees—pupil services		-61.703	-56.783
		(26.460)	(24.016)
% expenditures—support		-114.729	-80.026
		(33.228)	(21.023)
average teacher experience (years)		-0.788	-1.002
		(0.382)	(0.452)
average teacher tenure (years)		0.786	0.753
		(0.414)	(0.407)
% teachers—masters degree + 60 hrs.		0.158	0.124
		(0.079)	(0.066)
% teachers—masters degree		0.260	0.219
		(0.093)	(0.079)
% teachers—bachelors degree + 60 hrs.		0.083	0.088
		(0.054)	(0.064)
average teacher salary (in $1000's)		0.756	0.700
		(0.216)	(0.199)
constant		296.720	305.239
		(11.484)	(15.010)

Note: Standard errors are in parentheses.

to support a large number of school districts that provide higher quality schooling while serving a large percentages of black residents.

In sum, the results of this paper imply that the Tiebout sorting mechanism is not working effectively to match a great many minority and low-income households with their desired level of school quality. In the absence of major changes to the sizes of large urban public school districts, these results suggest that policies aimed at unbundling the schooling and housing decisions may result in substantial welfare gains for these households.

THE ROLE OF FAMILY IN THE EDUCATION PRODUCTION FUNCTION

This section presents the estimates of the education production function that control for the non-random sorting of households across communities. In order to provide a benchmark for gauging the importance of controlling for selection when estimating the education production function, the first column of Table 2 reports an estimate based on ordinary least squares. Not surprisingly, the average racial, parental education, and income characteristics of the families of a school district's children are highly correlated with the district's average achievement score. The specification of the education production function presented here also includes a variety of school characteristics–a measure of class size, budget allocation percentages, employee composition variables, and measures of average teacher education, experience, and salaries.

The estimates of the education production function that control for the sorting of households across communities and between the public and private sectors of the education market are presented in the second column of Table 2. These results imply that controlling for sorting reduces the role of family characteristics in the education production function by approximately 25-40 percent. In this way, a sizable portion of the differences in achievement traditionally associated with family background derive from the fact that households from relatively high socioeconomic backgrounds tend to choose better quality school districts. The results imply, therefore, that a substantial component of a school district's quality is not captured by the measurable school characteristics typically included in specifications of the education production function.

Taken together, then, the results of this analysis suggest that the commonly proclaimed conclusion that the family's contribution to a child's achievement dwarfs the school's contribution to achievement needs to be amended. In fact, while not diminishing the overall advantages that a child receives from his or her family background, this analysis implies that a significant portion of these advantages derives from the fact that households from higher socioeconomic backgrounds choose relatively better schools for their children. Moreover, the strong correlation between household characteristics and achievement should not lead one to conclude immediately that the contribution of the school to achievement is small. In fact, because it is difficult to capture those aspects of a school's quality that contribute to achievement, the strong correlation between family background and achievement is due in no small part to unobserved differences in school quality across public school districts.

THE PUBLIC-PRIVATE SCHOOL CHOICE

This section summarizes the results of Bayer (2001a), which estimates the determinants of the public-private school choice while controlling for the non-random sorting of households across communities. In brief, the results indicate that the failure to control for Tiebout sorting can lead to two serious forms of bias in the estimation of the determinants of the public-private school choice. Estimates that fail to account for sorting tend both to *understate* the importance of school characteristics in leading a household to choose private school and to *overstate* the role of family characteristics such as education and income in the choice decision. Intuitively, these biases can be attributed to the fact that households that send their children to private school tend to live in lower quality public school districts than other observationally equivalent households who send their children to public school. Thus, comparing the characteristics of a private school to the public schools in the same community tends to overstate the quality of the private school alternative available to the household and therefore tends to understate the importance of school characteristics in the decision. Also, conditioning on location, the stratification of households between the public and private sector appears more severe than it is in a more general equilibrium sense.

Table 1

Explaining Sociodemographic Differences in Consumption of School Quality

	predictions from full model	*hhlds differ only in employment locations*	households differ only in their preferences for		
			public school quality	*housing characteristics*	*peer/neighborhood sociodemographic characteristics*
Race:					
Black households	252.6	263.5	262.9	261.0	260.5
Hispanic households	254.1	264.1	262.1	263.0	260.3
Asian and white households	274.3	267.0	268.2	267.9	269.5
Black-white/Asian gap	21.7	3.5	5.3	6.9	9.0
Hispanic-white/Asian gap	20.2	2.9	6.1	4.9	9.2
Parental education:					
Households w/ a HS degree or less	255.9	264.5	258.8	264.2	263.1
Households w/ at least some college	277.3	267.1	273.8	267.4	268.8
Parental education gap	21.4	2.6	15.0	3.2	5.7
Income:					
Households with income < $40k	257.7	264.0	262.2	263.9	263.5
Households with income > $40k	275.9	267.8	270.2	268.1	268.6
Income gap	18.2	3.8	8.0	4.2	5.1

Note: Each column shows the predicted consumption of school quality that would result if households in the categoryshown in the row heading made their residential location decisions and school choices based only on the choice characteristics shown in the column heading. The first column depicts the consumption patterns predicted by the full model. The second column shows the predicted consumption patterns if households shared the same preferences but differed in their employment locations. The final three columns show the predicted consmption patterns that would result if households differed only in their initial endowments (income and employment location) and their preferences for school quality, housing characteristics, and peer socioeconomic composition, respectively.

essence, these simulations predict the residential location and school choices that households would have made if their decisions were based on their preferences for only one dimension of the bundled set of goods determined by the residential location decision. The key simulation explores how socio-economic differences in school quality consumption would change if households made these decisions based on their preferences for school quality alone. If the bundling of school quality with other local goods has no real effect, one would expect to see a matching of households with the quality of schools their children attend that is similar to the matching observed in the actual data.

The results of the simulations are shown in Table 1. The first column of the table shows the predicted consumption patterns if households sorted according to all of the factors considered in the model. The remaining columns show the predicted consumption patterns when households differ only in employment locations, preferences for school quality, housing characteristics, and peer/neighborhood socio-demographic characteristics, respectively.[4] Comparing the predicted consumption patterns under these various assumptions distinguishes the factors that drive the observed differences in the consumption of public school quality.

The first column of Table 1 reveals that minority households and households with less education and income tend to live in relatively poor quality school districts. The second column shows the pattern of school quality consumption that would result if households had identical preferences and income, and differed only in employment locations. These results imply that about 16 percent of the black-white school quality consumption gap and over 20 percent of the income gap can be explained by differences in the geography of employment opportunities.

When households differ only in their preferences for school quality (the third column), the predicted differences in the consumption of school quality between minority households and white/Asian households are substantially smaller than those observed in the data. In fact, differences in preferences for school quality can explain only about 24 percent of the black-white/Asian gap and 33 percent of the Hispanic-white/Asian gap. Differences in preferences for school quality do, however, explain almost 80 percent of the differences in the consumption of school quality across households with parental education.

The final two columns show the differences in consumption of school quality that can be explained by demand for housing and peer/neighborhood characteristics. It is immediately obvious that differences in preferences for housing and peer/neighborhood socio-demographic characteristics can explain a substantial potion (upwards of 30 percent for housing and 45 percent for socio-demographics) of the observed differences in school quality consumption attributable to race. Again, a similar result holds for the differences in consumption attributable to income.

The fact that black and Hispanic households live in poorer quality school districts despite having preferences for schooling similar to white and Asian households suggests that those minority households are particularly constrained by the bundling of schooling with the other local goods and geographic relationships jointly determined by the residential location decision. In fact, this *disconnect* between consumption patterns and preferences for minority households implies that certain bundles of local goods are not readily available in the market. In particular, my results imply that communities with relatively poor-quality housing and relatively good public schools as well as communities that provide high-quality public schooling in close geographic proximity to employment centers for low-income and minority households are not abundant.

The factor that explains the largest portion of the school quality gaps associated with race, however, is sorting on the basis of the socio-demographic characteristics of neighbors and peers. Moreover, although not shown, further analysis reveals that the preferences of households from all races to live and have their children attend school with others of the same race drives the majority of these effects. These results suggest, then, that many black and Hispanic households underconsume school quality in order to live in school districts with other black and Hispanic households. An obvious question arises–why communities that serve minority households with greater tastes for school quality do not develop. The answer, for the case of California, may lie in the fact that many black and Hispanic households live in the large urban public school districts. With a large portion of housing in these center cities and with black households, for example, representing less than 10 percent of the households in California's major metropolitan areas, there may simply be too few black households

eters properly. To do so, I introduce an IV approach for identifying social interactions in this framework. This identification strategy exploits the underlying geographic distribution of communities and their physical features within the major metropolitan areas of California. Again, see Bayer and Timmins (2000, 2001) for further details.

The Education Production Process and Measuring Preferences for Public School Quality

Another central feature of the empirical framework is the education production function, which characterizes the technology through which schools transform productive inputs (including the characteristics of students) into academic achievement. The education production function describes the determination of a district's average test score, τ_c, from the characteristics of the school, S_c–including average class and school size, average teacher experience, education, and salary, and the family backgrounds of the students, Z_c. To simplify the exposition that follows, assume that the production function is linear in family and school characteristics, as well as the stochastic term, ω_c:

$$(3) \quad \tau_c = \beta_1 Z_c + \beta_2 S_c + \omega_c$$

Here, ω_c represents the stochastic part of the production function and includes both the unobservable characteristics of the families attending public school and the unobservable characteristics of the public school district itself.

Because households sort across communities and between the public and private sector in a nonrandom way, the expectation of stochastic component of the education production function, ω_c, conditioned on the average family characteristics of its students is not equal to zero: consequently, estimates of the parameters of the production function based on OLS would be inconsistent. In essence, the following regression control for this selection problem:

$$(4) \quad (\tau_c - E(\omega_c \mid Z_{c,pub})) = \beta_1 Z_{c,pub} + \beta_2 S_c + \nu_c,$$

where $\nu_c = \omega_c - E(\omega_c \mid Z_{c,pub})$. By subtracting the conditional expectation of ω_c from both sides of the production function, we ensure that the new error term ν_c has a conditional mean of zero.

It is theoretically possible to solve for this conditional expectation given the estimated parameters of the utility specification and the data. In practice, however, the complicated nature of the demand system and the large number of choices make it impossible to specify a closed-form solution for the selection term. Consequently, I use a simple simulation procedure to calculate the selection correction term for each community.[3]

DATA

While the ideal data for estimating the model of community sorting developed above would match households with their particular school and community choices, such data are not available publicly for a large study area. To overcome this difficulty, I develop an estimation technique that makes use of two organizations of the 1990 Census covering the major metropolitan areas of California. First, the Public Use Microdata Sample provides *household-level* data containing detailed information about the characteristics of each household as well as some information about its choices of residence and school (e.g., its public-private school choice). Unfortunately, these data do not identify each household's residential location precisely enough to match the household accurately to its particular community and school (or school district), rendering traditional methods of estimating discrete-choice models unusable. I supplement the household-level Census data with a partially aggregated version of the same data organized at the *school district-level*, which provides information about the characteristics of the households that live in each school district, and, importantly, distinguish between households that send their children to private and to public schools.

Estimation of the household utility function proceeds, then, by selecting the preference parameters that best predict both the individual choices (e.g., private versus public schooling) observed in the household-level data as well as the distributions of households and their characteristics observed in the district-level data.

SOCIO-DEMOGRAPHIC DIFFERENCES IN THE CONSUMPTION OF SCHOOL QUALITY

Having estimated the parameters of the household utility function, Bayer (2001c) carries out a set of simulations designed to distinguish the factors that drive differences in the consumption of school quality across households with different racial, education, and income characteristics. In

followed by sections that summarize the data, describe the results of the three papers just introduced, and conclude.

AN EMPIRICAL FRAMEWORK FOR ANALYZING COMMUNITY SORTING

The principal component of the empirical framework used to analyze community sorting is a discrete-choice model of the residential location and schooling decisions (public versus private) of all households with school-aged children in the California study area. The model of utility maximization is based on the random utility framework developed in McFadden (1978) and the random-coefficients specification of Berry et al. (1995).

Each household chooses its residence and school type to maximize its utility, which depends on both the observable and unobservable characteristics of its choice. The household's choice set can be characterized by the triple *(c, s, h)*, where *c* represents community choice, *s* the school choice, and *h* the housing choice (including its tenure). Let X_c represent the observable characteristics that are determined by the household's community choice alone (e.g., climate, air quality, crime rates, urban density, and geographic location). Let X_{cs} represent the observable characteristics that vary with the household's choice of public versus private school, given that it has chosen community *c*. Note that the *cs* subscript here denotes the fact that these school characteristics vary with the household's community choice. In a similar manner, let X_{ch} represent the observable characteristics that vary with its community and particular housing choice including the annual housing cost, p_{ch}. Again, the characteristics of the housing units available to the household depend on the community choice that the household makes.

Each household's valuation of these choice characteristics is allowed to vary with its own (observable and unobservable) characteristics, z_i, and endowments. The observable household characteristics include parental education levels and race, and each household is initially endowed with a primary employment location, l_i, and income, y_i. Combining all of these elements, the household's optimization problem is given by:

$$(1)\quad \max_{(c,s,h)} V^i_{csh} = \alpha^i_c X_c + \alpha^i_s X_{cs} + \alpha_h X_{ch} - \alpha_p p_{ch} - \alpha^i_D D^i_c + \xi_c + \xi_{cs} + \xi_{ch} + \varepsilon^i_{csh}$$

where each parameter α^i_j, $j \in \{c, s, h, p, D\}$, is allowed to vary with a household's own (observable and unobservable) characteristics:

$$(2)\quad \alpha^i_j = \alpha_{0j} + \sum_{r=1}^{R} \alpha_{rj} z^i_r + \alpha_{yp} y^i + \upsilon^i_j.$$

and ξ_c, ξ_{cs}, and ξ_{ch} are fixed effects associated with each community *c*, (ξ_c), each school type *s* in community *c* (ξ_{cs}) and each housing choice *h* in community *c* (ξ_{ch}), respectively.

Equilibrium Considerations

Several features of this random-utility framework make it well suited to serve as the principal component of an equilibrium model of community sorting. First, the utility specification developed in equations (1) and (2) is extremely flexible–permitting preferences to vary with both observed and unobserved household characteristics and allowing the inclusion of unobservable choice characteristics. Without these unobservable choice characteristics, the model might very well predict upward sloping demand curves, as unobserved attractive features of a community, school, or house might increase the demand for a choice despite its higher price.

Second, the specification of an idiosyncratic component of preferences (ε^i_{csh}) implies that instead of each making the same optimal choice, households that are otherwise identical make choices with a probability that is continuous in the arguments of the utility function. By smoothing the discrete decision process, this feature of the random utility framework ensures that a sorting equilibrium always exists and that a unique vector of prices clears the market. While further development of these ideas is beyond the scope of this summary, see Bayer and Timmins (2000, 2001) for more detailed analyses of the equilibrium properties of these models.

Because households make their location and schooling decisions based in part on the unobservable choice characteristics (ξ_c, ξ_{cs}, ξ_{ch}), the socio-demographic composition of each community will be correlated with these unobservable components of utility. Moreover, other community attributes (e.g., school quality, crime) that depend on community composition also will be correlated with these unobservable choice characteristics in equilibrium. This correlation introduces an endogeneity problem that must be addressed in order to estimate the full set of preference param-

CONCLUSION

This dissertation aims to achieve two objectives. Most directly, it attempts to provide insight into the underlying factors that drive matching of households with their schools, thereby expanding our understanding of a complex issue that underlies a great deal of policy directed toward the poor and people in urban areas more generally. In a broader sense, however, its main objective is to expand our conceptual and empirical framework for thinking about many of the economic and social issues related to the interactions of the local public economy, education market, and urban land and labor markets. As the nature of the empirical analysis makes abundantly clear, these issues are complex and require a careful and rigorous empirical framework for proper analysis. Moreover, the consideration of these issues in a framework that oversimplifies the problem can lead quickly to an erroneous understanding of the world and, consequently, to misguided and potentially socially damaging policy.

Notes

[1] This particular scenario would be implied by much of the literature that advances the benefit view of zoning, such as Hamilton (1975) and (1976).

[2] Much of the education production function literature attempts to control for this problem by differencing out unobserved fixed effects. By looking, for example, at the increment to a child's test score when the child is in a smaller class versus a larger class, it is possible to estimate the effect of class size on achievement. Because most important family characteristics do not change over time, however, it is impossible to use a similar approach to estimate the role of the family in the production of achievement.

[3] For more information about this procedure, see Bayer (2001b).

[4] In calculating these simulations, I do not actually compute the new sorting equilibrium that would result if households had different preferences and sorted accordingly. Instead, each household in the sample continues to choose from the actual set of choices observed in the data, including the socioeconomic characteristics of its neighbors and child's peers.

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